# FishVis

**A Regional Decision Support Tool to Map the Response of Riverine Fish to Climate Change in the US Great Lakes Region**

Jana Stewart, Alex Covert, Nick Estes, Jen Bruce, Steve Westenbroek, Damon Krueger, Daniel Wieferich, Michael T. Slattery, John Lyons, James E. McKenna, Jr., and Dana Infante

# Understanding and Planning for Climate Change



**Climate change**

**Habitat**

**Temperature/flow**
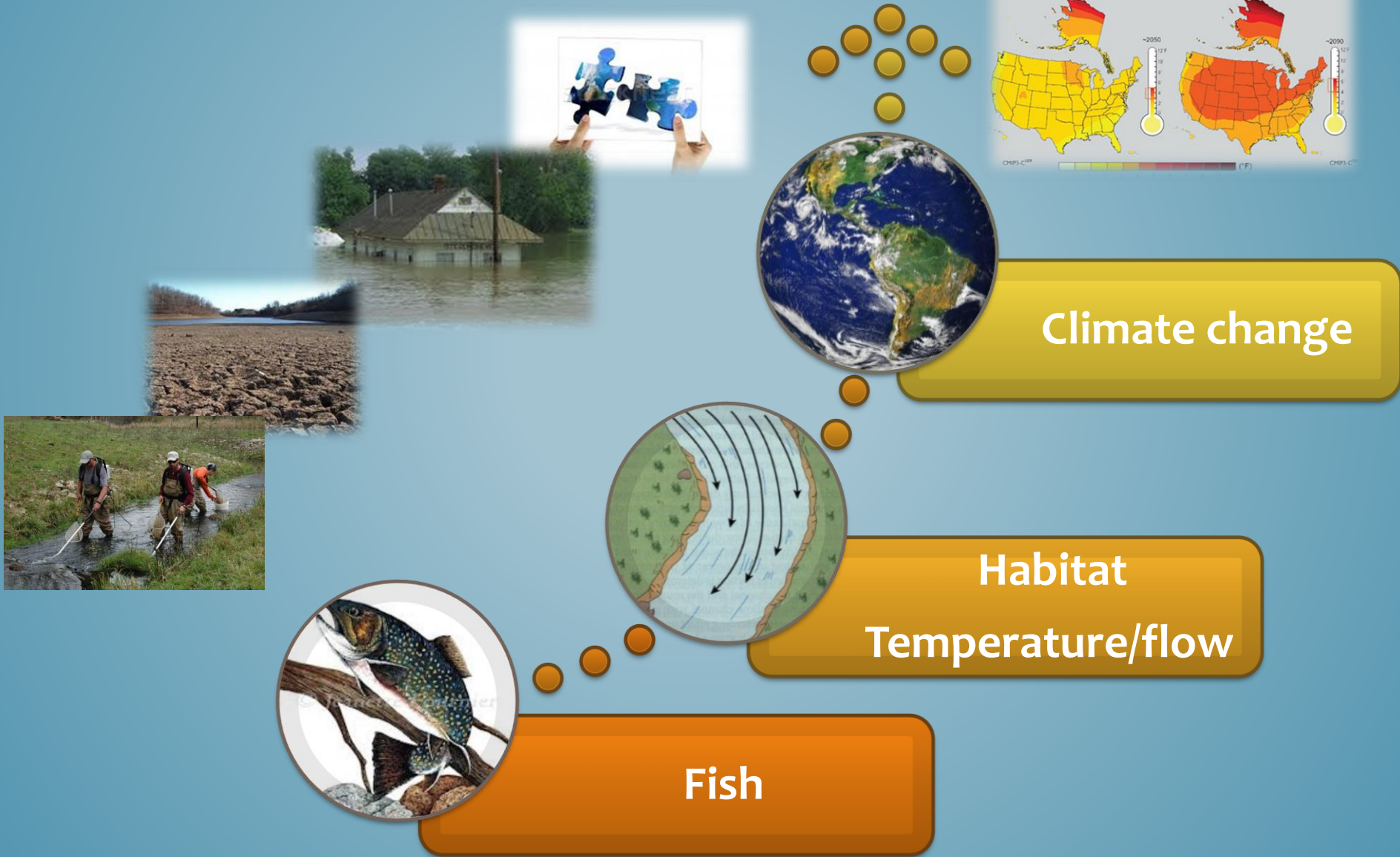
**Fish**

# Integrating Models to Predict Future Distributions



**Cold** FISH
Brook Trout
Brown Trout
Mottled Sculpin
Rainbow Trout

**Cool**
Blackchin Shiner
Brook Stickleback
Northern Hogsucker
Northern Pike
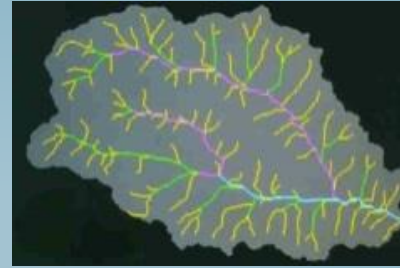White Sucker

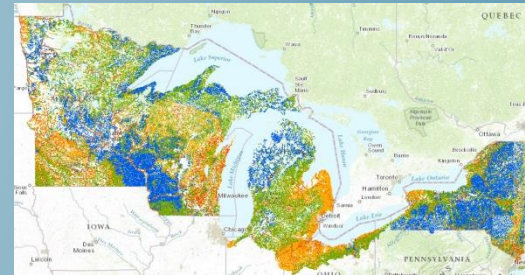**Warm**
Common Carp
Green Sunfish
Smallmouth Bass
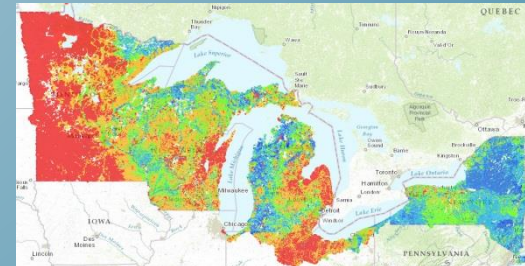Stonecat

**Model accuracy**
69 – 83 percent

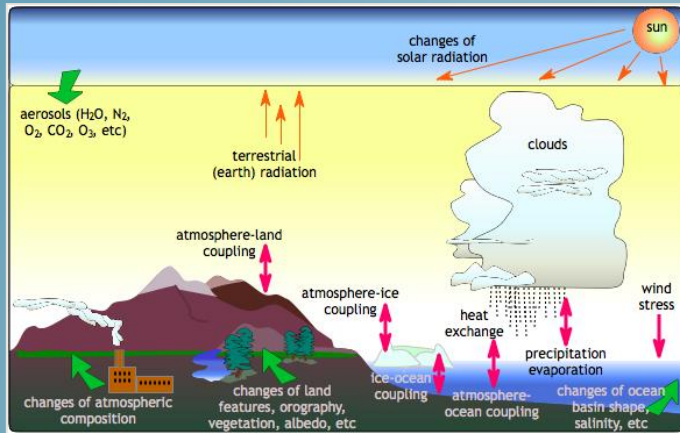**STREAM TEMPERATURE**

$R^2 = 0.71 – 0.76$

**STREAMFLOW EXCEEDANCE**
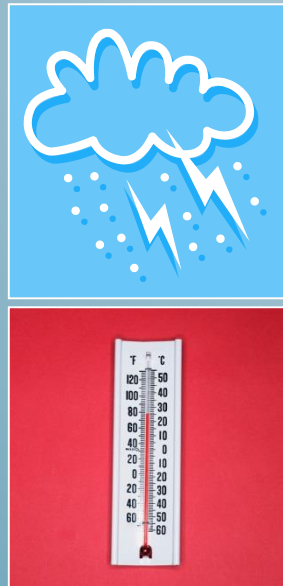
$R^2 = 0.89 – 0.95$

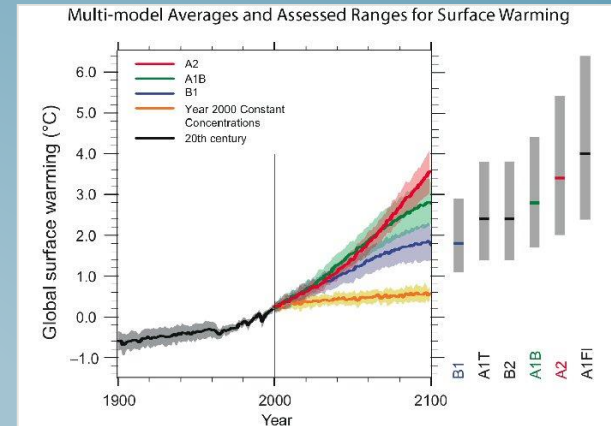# FISHVIS – Climate Inputs

## 13 General Circulation Models

## 1 Emissions Scenario (A1B)

**Statistically downscaled**



**Output:**

**Air temperature & precipitation**

- **13 GCMS**
- **time periods**
  - **Current**
  - **2046 – 2065**
  - **2081 - 2100**
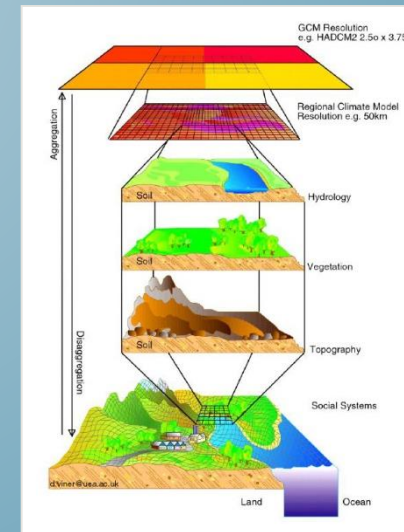


**(UW Madison – Center for Climatic Research – Dan Vimont and others)**

# The Big Question:
## WHAT WILL THIS MEAN FOR STREAMS AND THEIR FISHERIES?

# Species and Habitat Responses
## Present Day and Future

| Topic | Response | Time Period | |
|---|---|---|---|
| | | Present Day | Future |
| **Fish - Individual Species** | **Occurrence (P/A)** | x | x |
| | **Probability of occurrence** | x | x |
| | **Change in probability of occurrence** | | x |
| | **Vulnerability (Loss %)** | | x |
| | **Opportunity (Gain %)** | | x |
| | **Sensitivity (Loss or Gain %)** | | x |
| **Fish - Thermal Guilds** | **Occurrence (P/A)** | x | x |
| | **Number of species present** | x | x |
| | **Number of species lost** | | x |
| | **Number of species gained** | | x |
| | **Number of species lost or gained** | | x |
| | **Percent of species lost** | | x |
| | **Percent of species gained** | | x |
| | **Vulnerability (Loss %)** | | x |
| | **Opportunity (Gain %)** | | x |
| | **Sensitivity (Loss or Gain %)** | | x |
| **Stream Temperature** | **July mean (degrees C)** | x | x |
| | **Thermal class - July mean** | x | x |
| | **Change in degrees** | | x |
| | **Change in thermal class** | | x |
| **Streamflow Exceedance** | **Flow (Annual Q50, April Q10, August Q90)** | x | x |
| | **Yield (Annual Q50, April Q10, August Q90)** | x | x |

# StreamTemperature

**Cold and cold transition will decline**
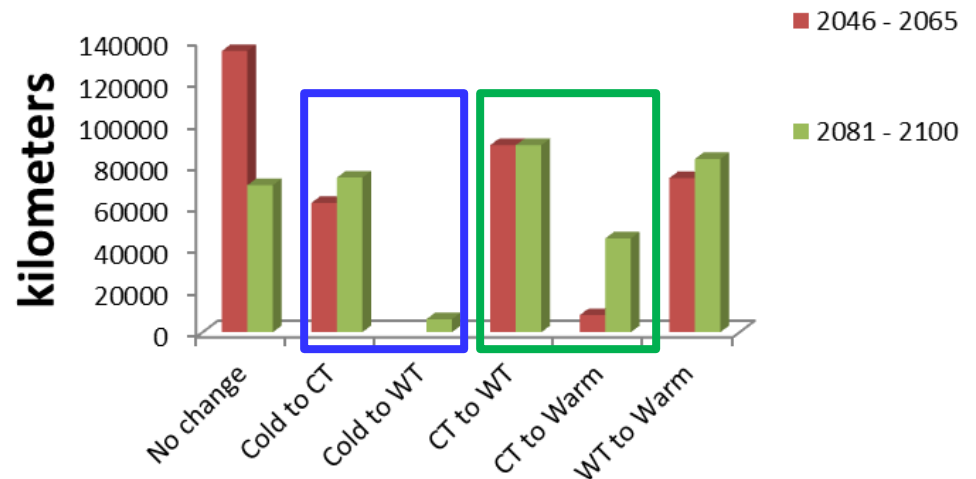
**Warm transition & warm will gain**

**Cold streams to Cold trans or Warm trans**

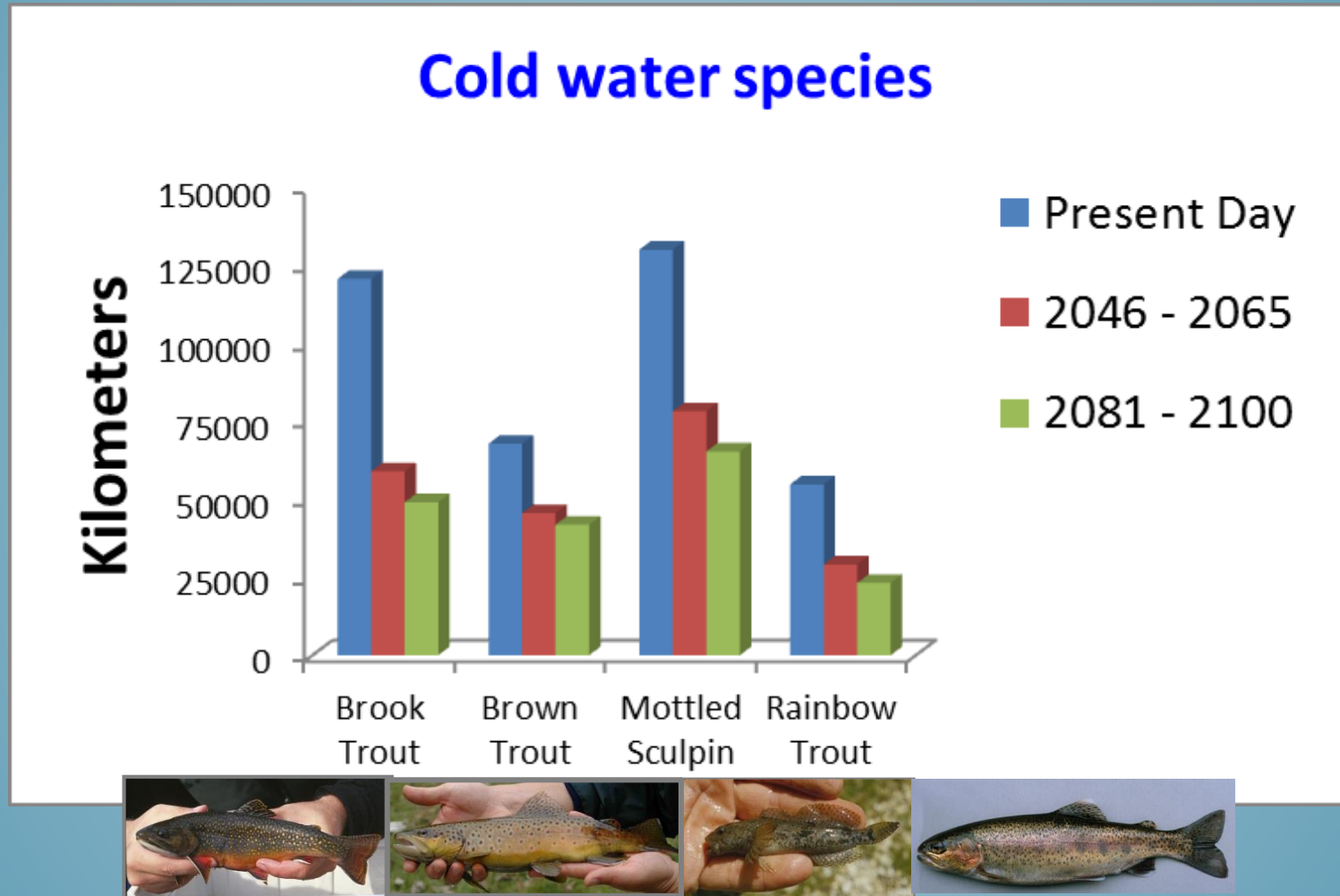**Cold transition streams to Warm transition or Warm**

**Warm transition streams to Warm**
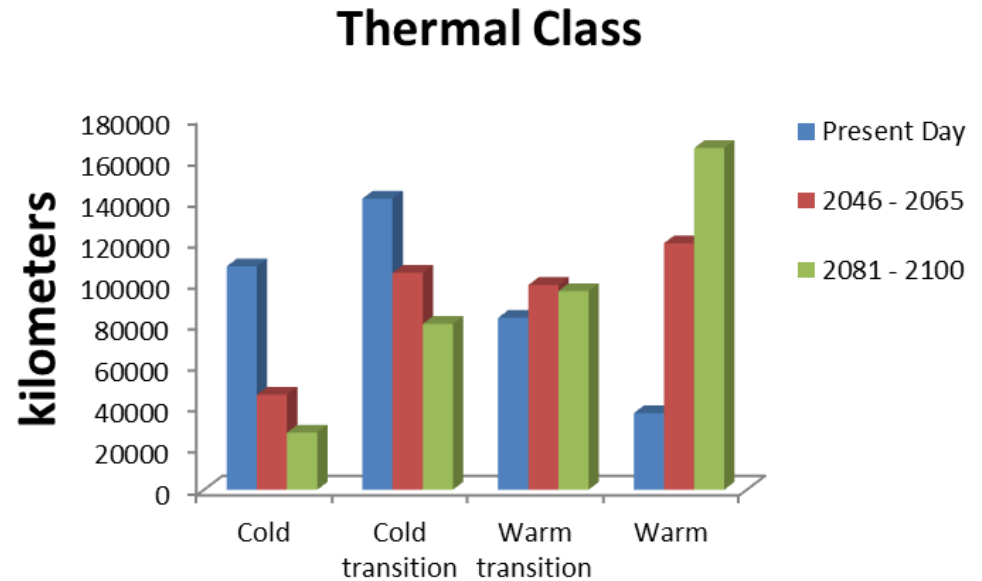
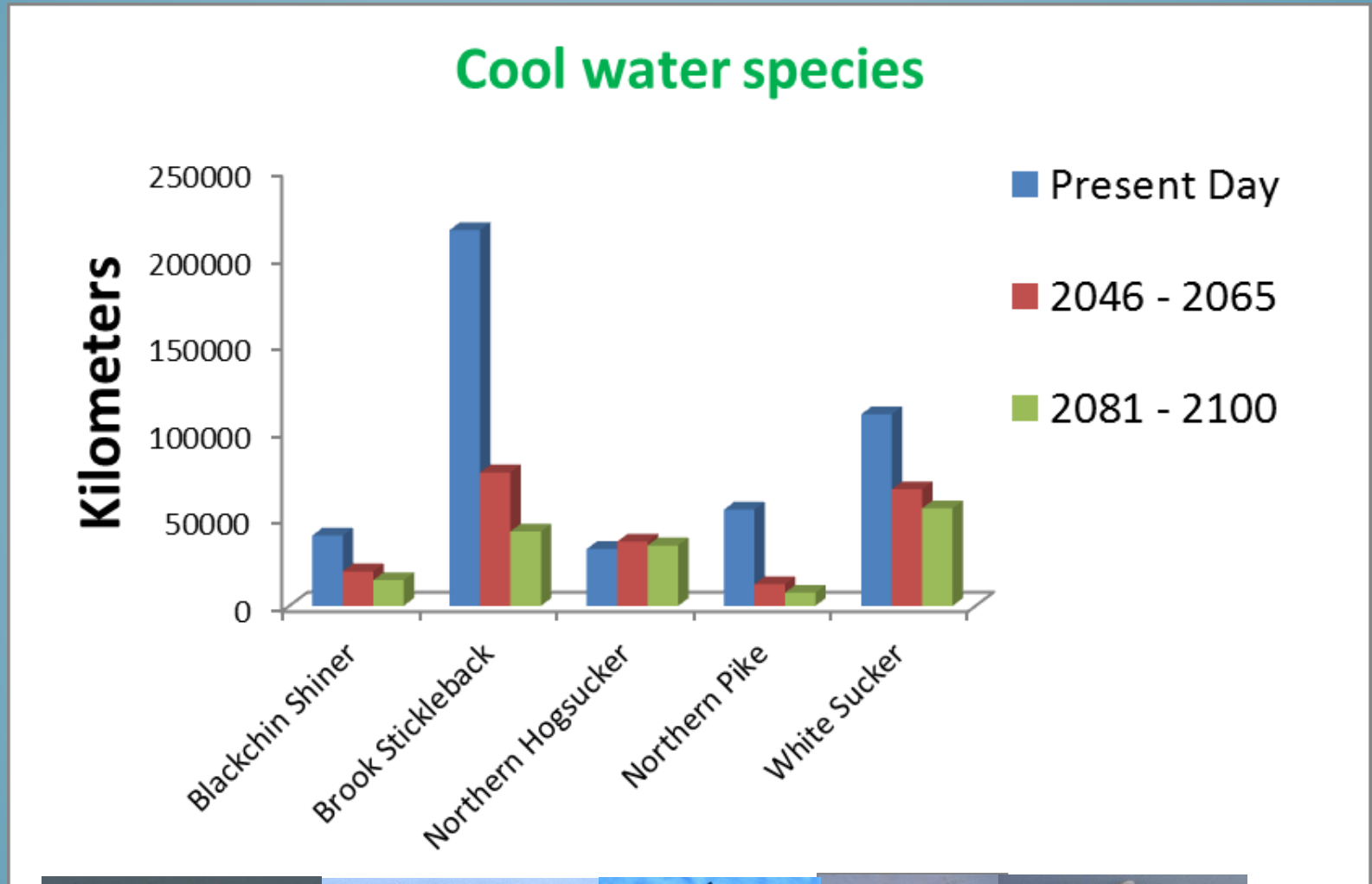

Thermal Class



Thermal Class Change from Present Day

# Current and Future Distributions: Cold



Cold water species will decline
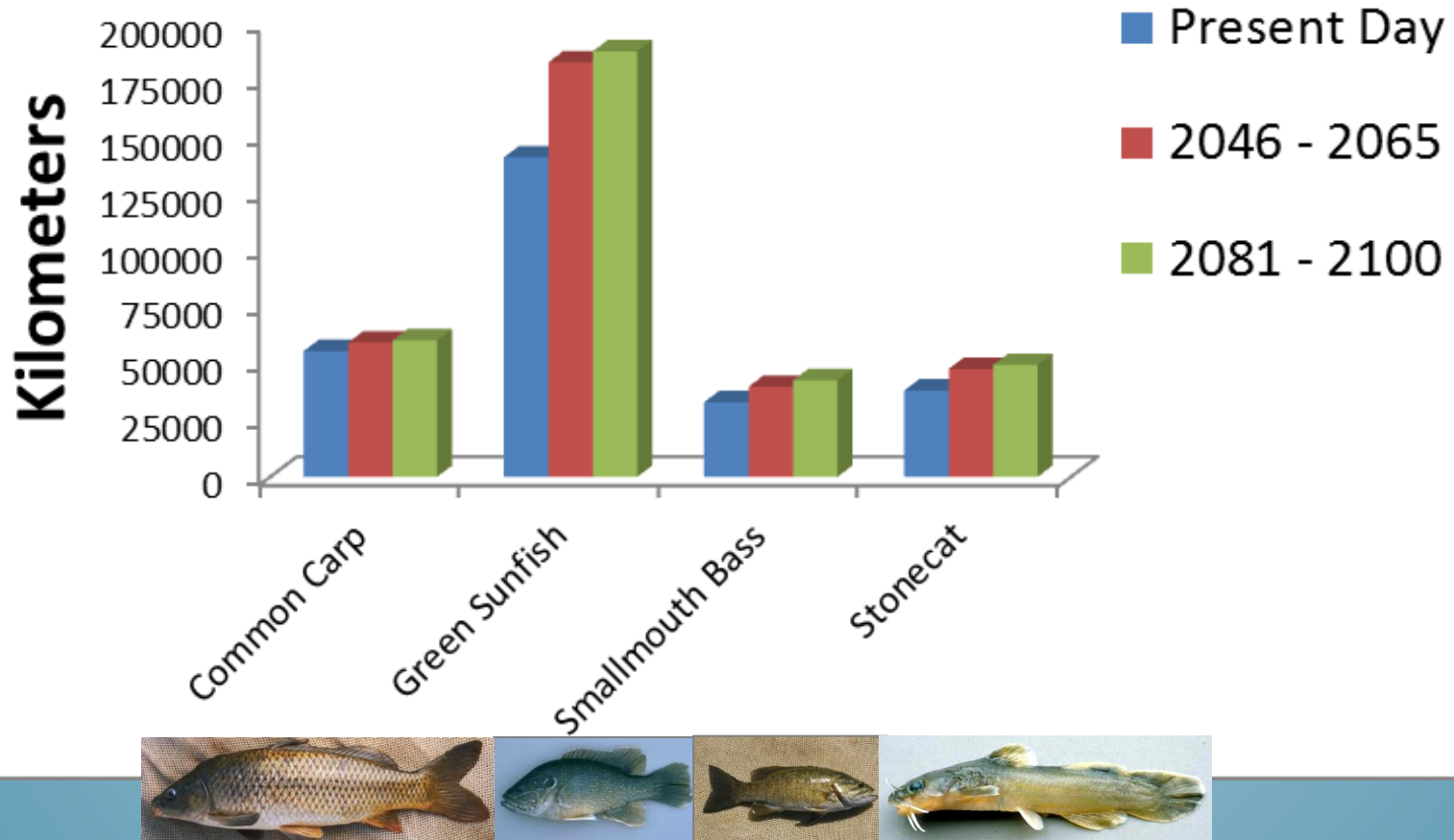
# Current and Future Distributions: Cool
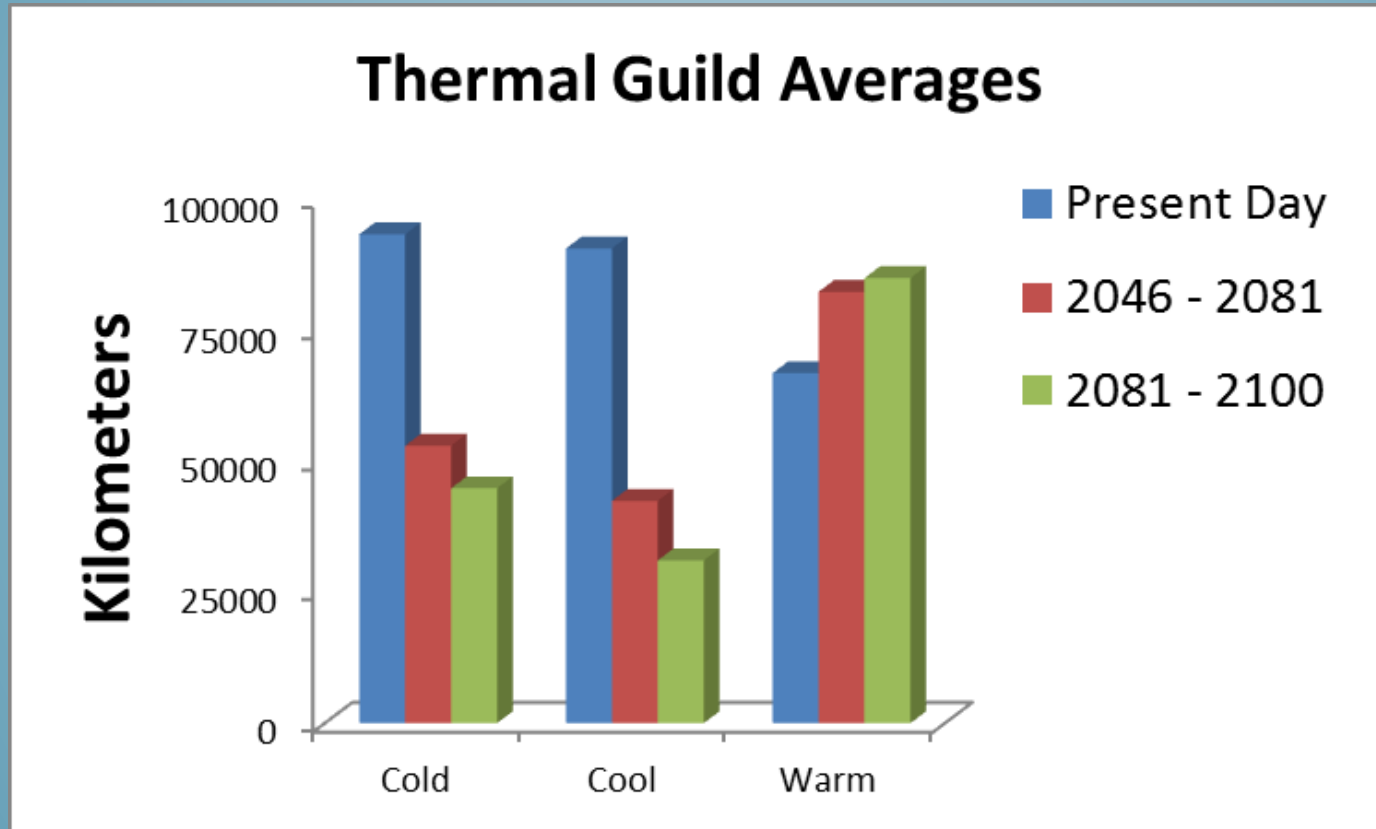


Cool water species will mainly decline

# Current and Future Distributions:  Warm



Warm water species

Warm water species will all increase in distribution

# Current and Future Distributions: Thermal Guild Averages



**Both Cold and Cool thermal guilds showed decreases**

# FishVis

- **Web-based decision support mapper**

- **Visualize potential climate driven responses for thermally representative fish species**

- **Tool for use by managers and scientists in understanding and decision making**

- **Choose base layers, Display, Navigate, View, Query, Download**
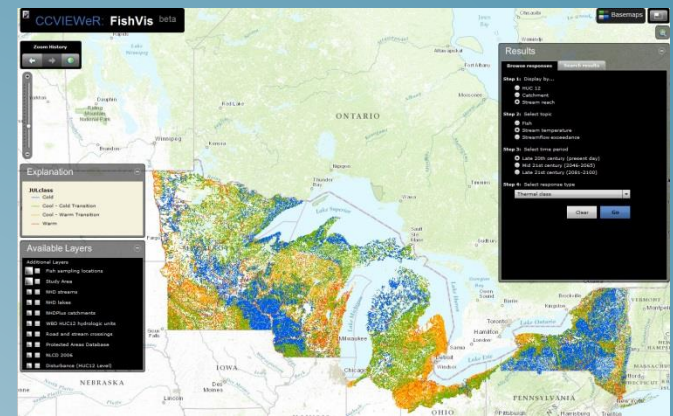
**Completion by September 2014**
*wimcloud.usgs.gov/apps/FishVisDev/FishVis.html#*

# *Browse results*



1. **Choose your display unit**

   **Reach**
   Catchment
   HUC12

2. **Select your topic**
   - **Fish – Brook Trout**
   - **Stream temperature**
   - **Streamflow exceedance**
   - **Climate**

3. **Select your time period**
   **Present,** Mid-21$^{st}$ or Late-21$^{st}$ century

4. **Select your response (i.e.)**
   - **probability of occurrence**
   - **thermal class**

# *Search results*

**Map only those results that meet your criteria**
- **Select spatial mapping unit**
- **Select spatial extent**
- **Enter criteria**
  - **Fish Species**
  - **Thermal class**
  - **Stream size**
  - **Land cover percent**
  - **Land stewardship**
  - **Time period**

# CHOOSE ADDITIONAL LAYERS

Contains a variety of additional data layers to use as a backdrop to enhance data exploration

- *FishVis sampling locations*

- *Study area*

- *NHD streams, lakes, and catchments; WBD HUC12s*

- *Road and stream crossings*

- *Protected Areas Database*

- *National Land Cover Database (2006)*
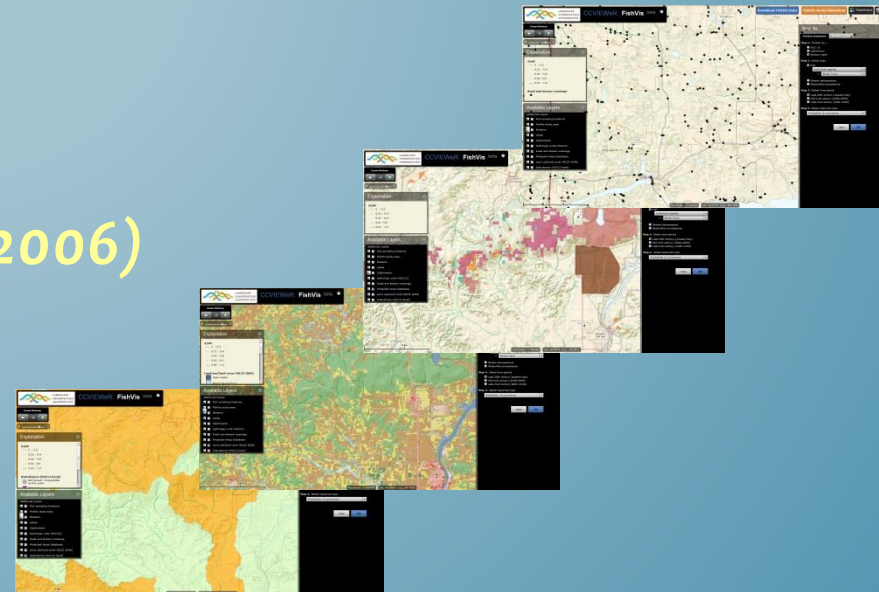
- *Disturbance (HUC12)*

## Available Layers

**Additional Layers**

- Fish sampling locations ?
- FishVis study area ?
- Streams ?
- Lakes ?
- Catchments ?
- Hydrologic units (HUC12) ?
- Road crossings ?
- Conservation status (PAD-US) ?
- Land use/land cover (NLCD 2006) ?
- ☑ Fish Habitat Condition Index (NFHAP) ?

# Use the results to help inform conservation planning



## FishVis facilitates:

- Assessment of current resources and future trends

    -fish species, stream temperature and flows

- Identification of resilient areas and areas likely to change

- Application of preliminary triage analysis
    1) <u>Protect</u>  (e.g., regulations, buffers) areas that retain desirable characteristics
    2) <u>Restore</u>  (e.g., better land-use ) areas that become marginal
    3) <u>Shift</u> emphasis (e.g., change species focus) where change is irreparable
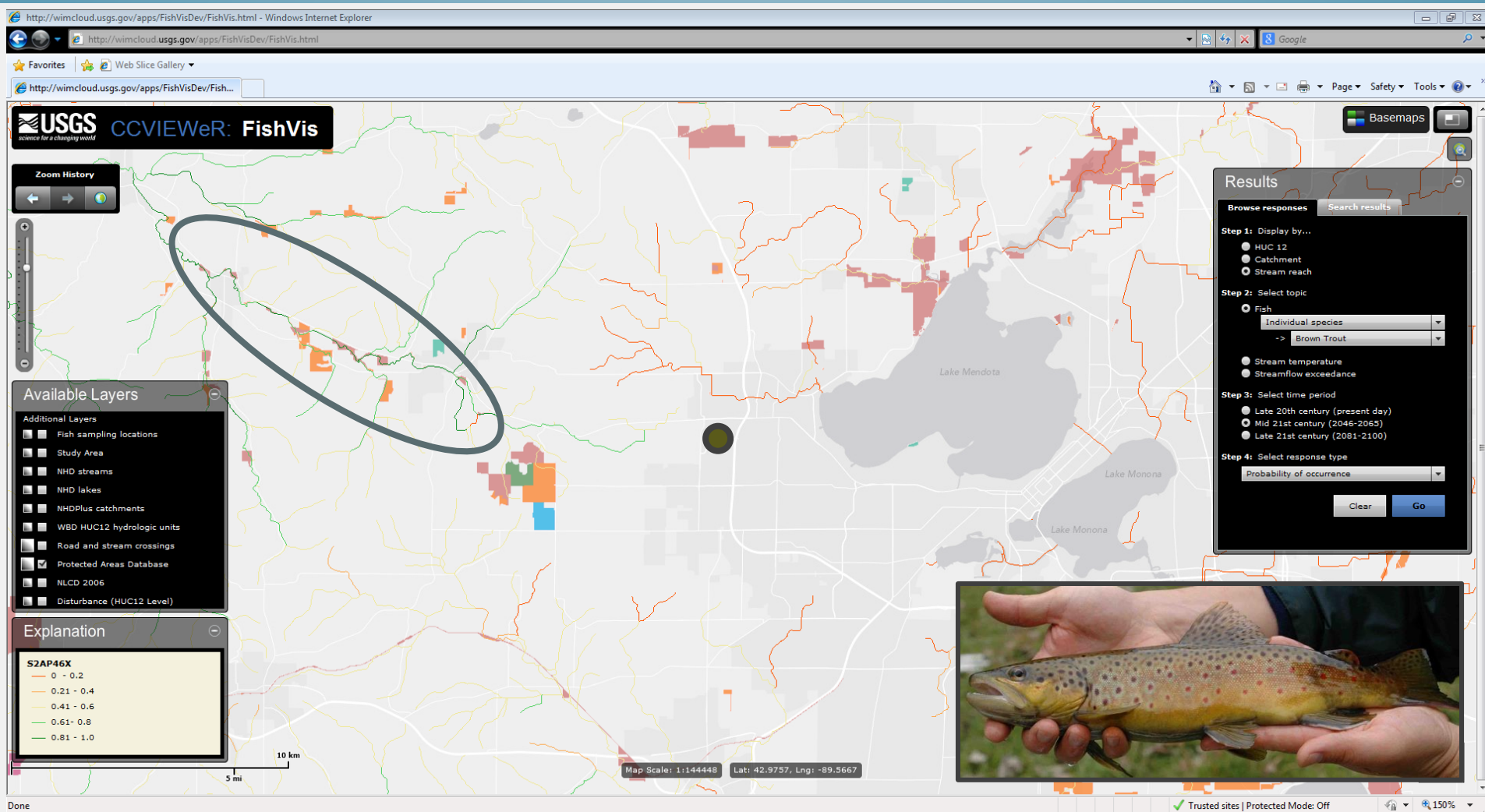
# Future Brown Trout Probability of Occurrence
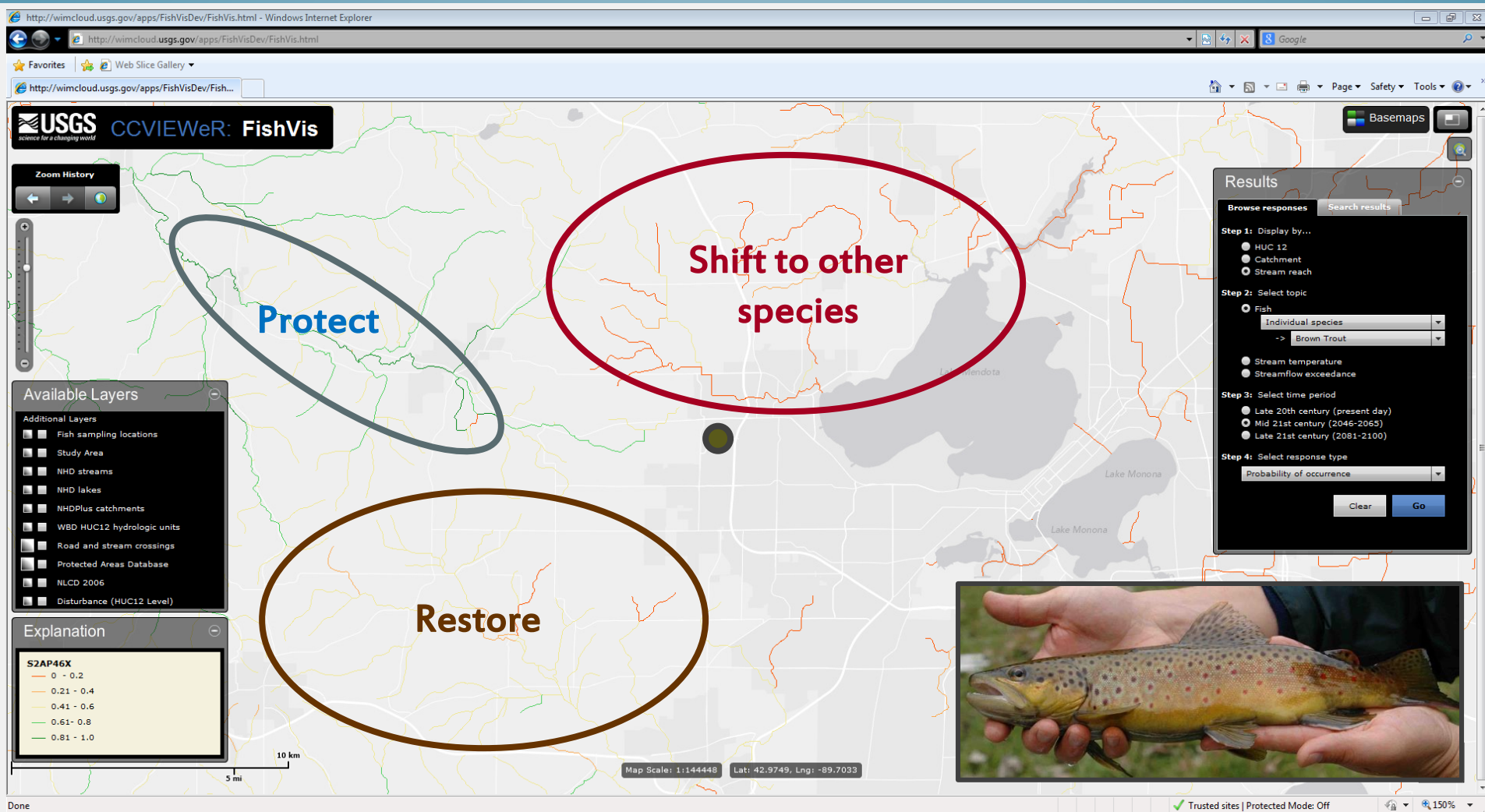


**Protect good areas, restore marginal areas, shift focus in poor areas**
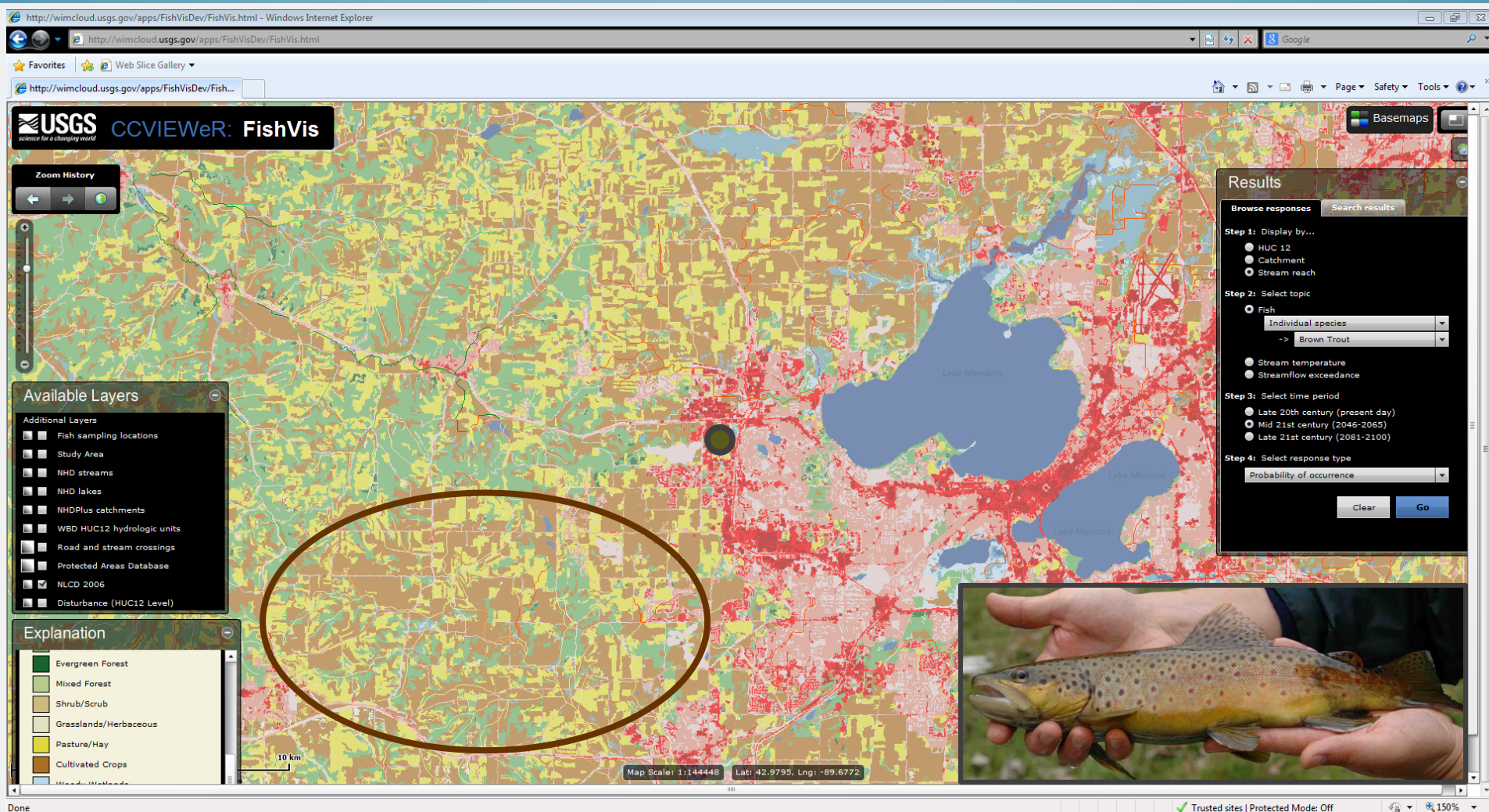
# Protect Good Areas – Currently Protected Lands



**Some protection already in place; should build on this**

# Restore Marginal Areas – Current Land Use



**Marginal area mainly agricultural; restoration challenging but possible**

# Tomorrow is the Future!



- **Fisheries changes are likely**
- **Changes will affect all species and areas**
- **Some species will decline; others will increase**
- **Managers need to be flexible in their thinking and planning for change**
- **We need to provide tools to help aid in decision-making**

*What our models don't account for….*

- **Future land cover change**
- **Stream temperature in other seasons  (non-summer)**
- **Species interactions**
- **Ecological connectivity (dams, road – stream crossings)**

# Thank You to our Funding Agencies, Cooperators, Users, and Data Providers
## (MN DNR, MN PCA, WI DNR, MI IFR, IN DNR, OH EPA, NY DEC)

*http://wim.usgs.gov/FishVisMapper/FishVis.html*